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GB 2298106 A GB 2296164 A WO 95/07587 A1
WO 92/13284 A1 WO 91/04616 A1 US 5432842 A
US 5218367 A

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(54) Tracking a moveable object

(57) Apparatus for tracking a moveable object has a conventional FM/AM radio receiver fitted to the moveable object which receives signals from a plurality of radio transmitters each at known locations. The strength of each signal is measured and the position of the moveable object relative to the transmitters by reference to the measured signal strengths is calculated. The absolute position of the object by reference to the known locations of the transmitters stored in memory is calculated. This information is then transmitted to a base station by means of a cellular digital telephone. The invention provides a cheap tracking device which does not required complex, large and expensive receiving or transmitting aerials. The device is compact and may be hid from thieves.

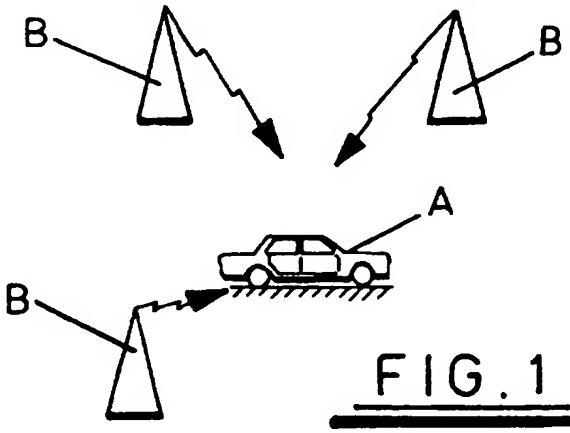

FIG. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

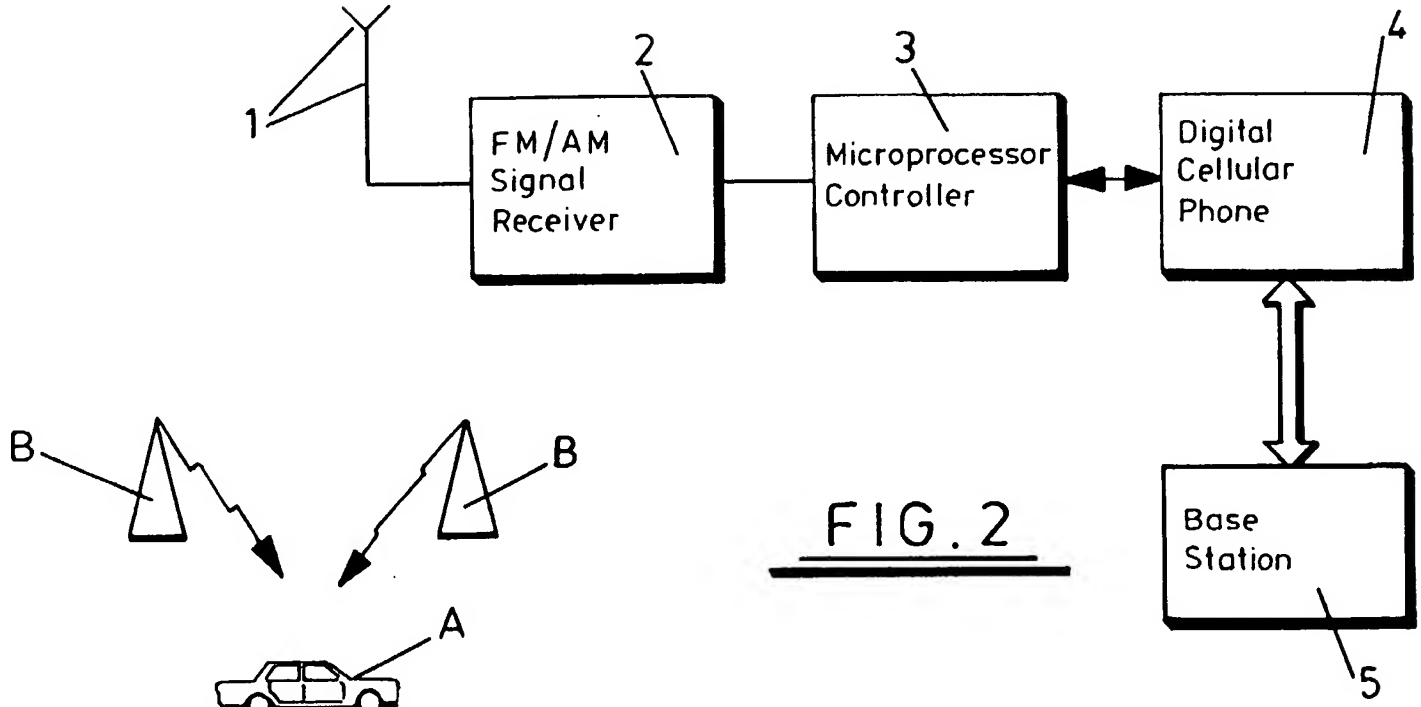
1
2
FM/AM
Signal
Receiver
3
Microprocessor
Controller
4
Digital
Cellular
Phone
Base
Station
5

FIG. 2

B
B
A
B

FIG. 1

1-2

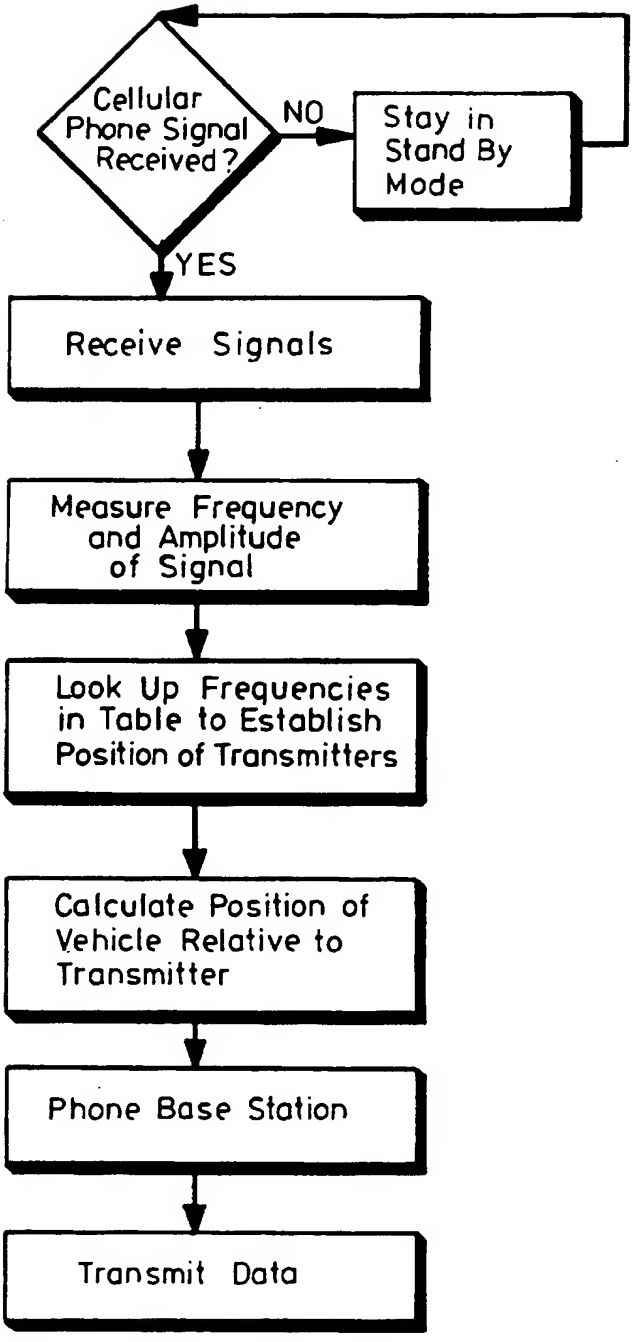
Cellular Phone Signal Received?
NO
Stay in Stand By Mode
YES
Receive Signals
Measure Frequency and Amplitude of Signal
Look Up Frequencies in Table to Establish Position of Transmitters
Calculate Position of Vehicle Relative to Transmitter
Phone Base Station
Transmit Data

FIG. 3

METHOD AND APPARATUS FOR TRACKING A MOVEABLE OBJECT

The present invention relates to a method and apparatus for tracking a moveable object, particularly but not exclusively, a motor vehicle.

It is well known to track the geographical location of a stolen object by analysing signals transmitted by the object. In order to do this the object has a tracking device comprising a receiver receptive to signals present in the surrounding environment and means for resolving the geographic location of the object by reference to the received signals. The device further comprises a transmitter which sends information relating to the global position to a central base station. In general, known tracking devices resolve the geographical location from signals broadcast by global positioning satellites orbiting the earth. Such tracking systems are expensive as the transmitters and receivers are complex and large. In addition, the large receiving aerials required are easily identified by a thief who will be prompted to destroy or inhibit the tracking system.

An additional problem is that stolen vehicles are often taken to a remote location or buried in the ground for significant periods of time before being retrieved. In such instances tracking systems fitted to the vehicle are not operational. When the vehicle is finally retrieved the battery power supplying the tracking system has generally been exhausted.

It is an object of the present invention to obviate or mitigate the aforesaid disadvantages.

According to a first aspect of the present invention there is provided a method for tracking a moveable object comprising the steps of:

(a) receiving signals from a plurality of transmitters each at known locations;

(b) measuring the strength of each signal;

(c) calculating the position of the moveable object relative to the transmitters by reference to the measured signal strengths;

(d) calculating the absolute position of the object by reference to the known locations of the transmitters; and

(e) transmitting information identifying the current location of the object to a base station.

Preferably the signals received are FM or AM radio waves transmitted by known radio transmitters. Three signals may be received and calculation of the location of the moving object is performed by triangulation.

In one particular embodiment the direction from which the signals are received is detected.

Preferably the information is transmitted to the base station by a cellular digital telephone.

According to a second aspect of the present invention there is provided apparatus for tracking a moveable object comprising:

a receiver connected to a moving object for receiving signals from a plurality of first transmitters each at known locations;

means for measuring the strength of each signal;

means for calculating the position of the moveable object relative to the first transmitters by reference to the measured signal strengths;

means for calculating the absolute position of the object by reference to the known locations of the first transmitters stored in a memory; and

a second transmitter for transmitting information identifying the current location of the object to a base station.

Preferably the receiver is a FM/AM radio receiver and the first transmitters are radio transmitters broadcasting FM/AM signals.

The means for calculating the position of the moveable object and the means for calculating the absolute position of the object is preferably a microprocessor having a memory in which the known locations of the first transmitters are stored.

Preferably the second transmitter is a cellular digital telephone controlled by the microprocessor

In a preferred embodiment there is provided a directional antenna for detecting the direction from which the signals are received.

Preferably the telephone is powered by a battery and when the telephone is inactive for a predetermined period of time it assumes a stand-by mode in which reduced battery power is consumed

A specific embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of three radio transmitters and a moving vehicle to be tracked;

Figure 2 is a block diagram of tracking apparatus according to an aspect of the present invention; and

Figure 3 is a flow diagram of the method of tracking a moveable object

Referring now to the drawings, Figure 1 shows a moving vehicle A fitted with an FM/AM receiver for receiving signals broadcast from a plurality of commercial radio transmitters B operating at different geographic locations.

The vehicle is fitted with a tracking device which is shown in schematic form in figure 2. Its operation is shown in the form of a flow diagram in figure 3. Signals broadcast from the transmitters B are picked up by an aerial 1 fitted to the vehicle and passed to a receiver unit 2 in the conventional way. The receiver unit 2 is a conventional FM/AM commercial radio receiver which has the capability of measuring the amplitude and frequency of a signal received from any one of the transmitters B. The receiver unit 2 is connected to a microprocessor 3 where the signals are processed in a manner described in detail below and which is in turn connected to a digital cellular telephone 4. The phone 4 is used to send data regarding the vehicle location to a base station 5.

The measured parameters of frequency and amplitude are passed to the microprocessor controller 3 which is supplemented with memory containing the geographic data for all the ground based commercial transmitters required. The data is accessible as a table of geographic locations against signal frequency. As each transmitter broadcasts with a unique frequency, once the frequency of the

transmission is established the geographic location of that transmitter can be established.

The amplitude values of the detected signals are then used to calculate the position of the vehicle relative to the transmitters B from which signals are received. For a given received signal, the amplitude is related to the distance of the vehicle A from the transmitter B. When the signal strength from three separate transmitters has been established it is possible to calculate by triangulation the position of the vehicle A relative to the transmitters B. Combining this information with the geographic location of the transmitters, it is possible to establish the absolute geographical location of the vehicle. It will be understood that the microprocessor 3 can process the received signals according to a simple algorithm to make these calculations.

The digital cellular phone 4 is of conventional design and comprises a transmitter, receiver and a microprocessor operated dialling mechanism. The base station 5 has a receiver to receive data from the cellular phone 4 and a microprocessor (not shown) which converts the data into a meaningful form. The data may be transmitted by the tracking device in coded form. Instructions may be transmitted from the base station microprocessor to the tracker by an operator in order to make further investigations relating to the status of the vehicle.

The microprocessor 3 in the vehicle may be connected to other transducers so that other information regarding the status of the vehicle may be transmitted to the base station such as the vehicle's mileage, speed, or fuel consumption etc.

If the vehicle is taken to a remote location or buried the cellular phone signal and/or the radio broadcasts will not be received or will be too weak to detect. In this instance the digital phone resorts to standby mode and the system is not operational in order to save on battery power. As soon as a cellular phone interrogation signal is received the digital phone reverts to operative mode, processing of the radio signals can be resumed and attempts to contact base station are made in the normal way.

The present invention has the significant advantage that the equipment fitted to the vehicle is compact and can be hidden easily from the view of thieves. A large aerial is not required by the FM/AM receiver or the transmitter on the digital phone

and these can both be hidden discreetly in, for example, a box. Such aerials can be used in any orientation without any significant deterioration in performance.

By measuring the strength of FM/AM signals using a conventional commercial radio receiver the tracking system is significantly less expensive than current systems on the market.

Moreover, the system is designed to remain operative even if the vehicle is hidden or buried for a significant period of time.

It will be understood that the method and apparatus of the present invention are not limited to the tracking of stolen vehicles but may be used to track any stolen item e.g. computer equipment. Moreover, the method and apparatus may be used in fleet management of vehicles by transportation companies or departments or the like.

It will be appreciated that numerous modifications to the above described design may be made without departing from the scope of the invention as defined in the appended claims. For example, the FM/AM receiver may be supplemented by a conventional directional antenna to provide directional information to assist in the calculation of the vehicle location. In addition the vehicle may be fitted with a small hidden CDC camera connected to the microprocessor. The camera can send to the base station frame by frame pictures of the driver's area in digital form to be processed and reproduced at the base station.

CLAIMS

1. A method for tracking a moveable object comprising the steps of:

(a) receiving signals from a plurality of transmitters each at known locations;

(b) measuring the strength of each signal;

(c) calculating the position of the moveable object relative to the transmitters by reference to the measured signal strengths;

(d) calculating the absolute position of the object by reference to the known locations of the transmitters; and

(e) transmitting information identifying the current location of the object to a base station.

2. A method according to claim 1, wherein the signals received are FM or AM radio waves transmitted by known radio transmitters.

3. A method according to claim 1 or 2, wherein three signals are received and calculation of the location of the moving object is performed by triangulation.

4. A method according to any preceding claim, further comprising the step of detecting the direction from which the signals are received.

5. A method according to any preceding claim, wherein the information is transmitted to the base station by a cellular digital phone.

6. Apparatus for tracking a moveable object comprising:

a receiver connected to a moving object for receiving signals from a plurality of first transmitters each at known locations;

means for measuring the strength of each signal:

means for calculating the position of the moveable object relative to the first transmitters by reference to the measured signal strengths;

means for calculating the absolute position of the object by reference to the known locations of the first transmitters stored in a memory; and

a second transmitter for transmitting information identifying the current location of the object to a base station.

7. Apparatus according to claim 6, wherein the receiver is an FM/AM radio receiver and the first transmitters are radio transmitters broadcasting FM/AM signals.

8. Apparatus according to claim 6 or 7, wherein the means for calculating the position of the moveable object and the means for calculating the absolute position of the object is a microprocessor.

9. Apparatus according to claim 8, wherein the microprocessor has a memory in which the known locations of the first transmitters are stored.

10. Apparatus according to any one of claims 6 to 9, wherein the second transmitter is a cellular digital telephone.

11. Apparatus according to claim 10 when dependent from claim 8, wherein the cellular digital telephone is controlled by a microprocessor.

12. Apparatus according to any one of claims 6 to 11, wherein there is provided a directional antenna for detecting the direction from which the signals are received.

13. Apparatus according to claim 10 or 11, wherein the telephone is powered by a battery and when the telephone is inactive for a predetermined period of time it assumes a stand-by mode in which reduced battery power is consumed.

14. A method of tracking a moveable object substantially as hereinbefore described with reference to the accompanying drawings.

15. Apparatus for tracking a moveable object substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

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Application No: GB 9516559.3 **Examiner:** Dr E P Plummer
Claims searched: all **Date of search:** 30 September 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4D(DD,DPBC,DLRJ,DLPE,DLAB); G1G(GRA); H4L(LDSL)

Int Cl (Ed.6): G01S, H04Q

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
XE	GB2298106A	NEC Corp eg abstract	1,2,5,6,7, 8,9,10,11
XE	GB2296164A	NEC Corp eg abstract	1,2,5,6,7, 8,9,10,11
X	WO95/07587A1	Ericsson GE Mobile Communications eg abstract, page 9 line 14 to 35	1,2,3,5,6, 7,8,9,10, 11,13
X	WO92/13284A1	Song eg abstract	1,2,3,5,6, 7,8,9,10, 11,13
X	WO91/04616A1	Nippon Telegraph and Telephone Corp eg abstract	1,2,5,6,7, 8,9,10,11, 13
X	US5432842	Hitachi eg abstract	1,2,3,5,6, 7,8,9,10, 11,13
X	US5218367	Trackmobile eg abstract	1,2,3,5,6, 7,8,9,10, 11,13

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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